

DEC 13 2001

JC18 Rec'd PCT/PTO 13 DEC 2001

|   |   |  |
|---|---|--|
| FORM PTO-1390<br>(REV 11-2000)  | U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE | ATTORNEY'S DOCKET NUMBER<br><b>3573-11</b>   |
| TRANSMITTAL LETTER TO THE UNITED STATES<br>DESIGNATED/ELECTED OFFICE (DO/EO/US)<br>CONCERNING A FILING UNDER 35 U.S.C. 371  |   | U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)<br><b>10/009497</b><br>to be assigned |
| INTERNATIONAL APPLICATION NO.<br><b>PCT/IB00/00786</b>  | INTERNATIONAL FILING DATE<br><b>13 June 2000</b>        | PRIORITY DATE CLAIMED<br><b>14 June 1999</b>   |
| TITLE OF INVENTION<br><b>SYSTEM OF DIGITAL PHASE AND AMPLITUDE MODULATION (PSK/ASK)</b>   |   |  |
| APPLICANT(S) FOR DO/EO/US<br><b>MARIOTTI et al</b>  |   |  |
| <p>Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.</li> <li><input checked="" type="checkbox"/> The U.S. has been elected by the expiration of 19 months from the priority date (Article 31).</li> <li>A copy of the International Application as filed (35 U.S.C. 371(c)(2)).             <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li><input checked="" type="checkbox"/> has been communicated by the International Bureau.</li> <li><input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).             <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto.</li> <li><input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</li> </ol> </li> <li><input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).             <ol style="list-style-type: none"> <li><input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li><input type="checkbox"/> have been communicated by the International Bureau.</li> <li><input type="checkbox"/> have not been made; however, the time limit for making such amendments has <b>NOT</b> expired.</li> <li><input type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li><input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li><input type="checkbox"/> A English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol> <p><b>Items 11 To 20 below concern document(s) or information included:</b></p> <ol style="list-style-type: none"> <li><input type="checkbox"/> An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.</li> <li><input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.</li> <li><input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment.</li> <li><input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li><input type="checkbox"/> A substitute specification.</li> <li><input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li><input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.</li> <li><input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).</li> <li><input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).</li> <li><input checked="" type="checkbox"/> Other items or information. PTO-1449 and International Search Report</li> </ol> |   |  |

Shirley Beecan  
SIGNATURE

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent Application of

MARIOTTI et al

Atty. Ref.: 3573-11

Serial No. to be assigned

Group:

Filed: December 13, 2001

Examiner:

For: SYSTEM OF DIGITAL PHASE AND AMPLITUDE MODULATION (PSK/ASK)

\* \* \* \* \*

Assistant Commissioner for Patents  
Washington, DC 20231

Sir:

**PRELIMINARY AMENDMENT**

In order to place the above-identified application in better condition for examination, please amend the application as follows:

**IN THE CLAIMS**

Please amend claim 3 as follows: A copy of the amended claim showing current revisions is attached.

3. {AMENDED} Method of modulation as claimed in claim 1, which is provided by means of a circuitry comprising in cascade a bit source, a digital phase modulator (PSK) in baseband and, in a single block, a voltage controlled oscillator, a multiplier and a power amplifier.

**MARIOTTI et al**  
**Serial No. to be assigned**

Please add new claim 4 as follows:

-- 4. {AMENDED} Method of modulation as claimed in claim 2, which is provided by means of a circuitry comprising in cascade a bit source, a digital phase modulator (PSK) in baseband and, in a single block, a voltage controlled oscillator, a multiplier and a power amplifier. --

**REMARKS**

The above amendments are made to place the claims in a more traditional format.


Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page(s) is captioned "**Version With Markings To Show Changes Made.**"

Respectfully submitted,

**NIXON & VANDERHYE P.C.**

December 13, 2001

By: \_\_\_\_\_



H. Warren Burnam, Jr.

Reg. No. 29,366

HWB:lsb  
1100 North Glebe Road, 8th Floor  
Arlington, VA 22201-4714  
Telephone: (703) 816-4000  
Facsimile: (703) 816-4100

**MARIOTTI et al**  
Serial No. to be assigned

**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**IN THE CLAIMS**

3. {AMENDED} Method of modulation as claimed in [claims 1 and 2] claim 1, which is provided by means of a circuitry comprising in cascade a bit source [(1)], a digital phase modulator (PSK) [(2)] in baseband and, in a single block, a voltage controlled oscillator [(3)], a multiplier [(4)] and a power amplifier [(5)].

13 DEC 2001

WO 00/77997

PCT/IB00/00786

1

01:00

"SYSTEM OF DIGITAL PHASE AND AMPLITUDE MODULATION (PSK/ASK)"

ooo@ooo

#### FIELD OF THE INVENTION

This invention refers to a system of phase and amplitude modulation (PSK/ASK), which allows a significant improvement of the spectral efficiency, with a small increase of the complexity of construction.

Namely, this system provides a simple way to increase spectral efficiency (i.e. to increase bit rate with the same spectrum occupancy) with a minimum impact on transmitter complexity, allowing however a working point of the same very close to the saturation, and with small requirements on phase noise, with respect to the conventional linear RF transmitters, which utilise non-circular constellations of the type M-QASK.

#### STATE OF ART AND RELATED PROBLEMS

The linearity of the transmission chain - particularly in the last stage of said chain, which is the power amplifier (that should be allowed to work far enough from its saturation, i.e. to exhibit a sufficient output back-off to provide amplitude modulation) - and the stability of the RF oscillator are among the most severe requirements in medium-high capacity radio systems.

In a traditional system of quadrature amplitude modulation (QAM) or in a traditional system of amplitude and phase modulation (PSK/ASK) it is possible to achieve, by ensuring a very low RF distortion and a very low phase noise, to meet quality requirements (low bit error rate - BER) for the modern telecommunication networks. However, this causes design difficulties and, accordingly, high costs.

This invention aims at achieving the same results in a much more simple way, obtaining a high increase in the spectral efficiency, a high operation flexibility and a high reliability of the system performance. Since the invention

requires a very small increase of system and hardware complexity, it also lowers the production costs.

#### SUMMARY OF THE INVENTION

With the above aims, this invention refers to a system of phase and amplitude modulation (PSK/ASK) of a single information flow, characterised in that a phase modulation in baseband and a RF frequency modulation are performed separately by using different portions of the same information flow as a modulating signal.

Preferably, a standard, digital phase modulation (PSK) is implemented in baseband in this system of modulation and the number of symbols or signals which form the constellation alphabet is increased by overlapping a digital amplitude modulation (ASK) which is synchronous with the bit flow, directly to a radiofrequency.

Advantageously, M discrete phase-shift levels in baseband and N discrete RF levels of amplitude can be used in the same system.

The system of modulation according to the invention is effectively provided by means of a circuitry comprising in cascade a bit source, a digital phase modulator (PSK) in baseband and, in a single block, a voltage controlled oscillator, a multiplier and a power amplifier.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described in greater detail below, referring to the figures in the annexed drawing, wherein:

Fig. 1 is a block diagram showing the circuitry to provide the system of modulation according to the invention;

Fig. 2 shows an example of scheme or constellation, wherein the inventive system of modulation is realised, in the case of four phase levels and two amplitude levels;

Fig. 3 shows another constellation, which is similar to the previous one in Fig. 2, but wherein an additional RF phase shift by  $90^\circ$  is introduced; and

Figs 4 and 5 show two other examples of constellations according to the invention.

#### DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

The block diagram in Fig. 1 of the annexed drawings, showing a circuitry by means of which the inventive system of modulation is provided, comprises in cascade a bit source 1, a digital phase modulator (PSK) 2 in baseband and, in a single block, a voltage controlled oscillator 3, a multiplier 4 and a power amplifier 5.

A system of phase and amplitude modulation (PSK/ASK) of a single information flow is provided through the arrangement in Fig. 1, by separately performing a phase modulation in baseband in modulator 2 and an amplitude RF modulation in the block 3, 4, 5, by using discrete portions of the same information flow as modulating signal.

More precisely, a digital standard base modulation (PSK) is implemented in baseband and the number of symbols or signals constituting the costellation alphabet is incremented, by overlapping a digital amplitude modulation (ASK), that is synchronous to the bit flow, directly to RF.

M discrete levels of baseband phase-shift and N discrete levels of RF amplitude can be used in the inventive system of modulation, conveniently providing substantially circular costellations.

Referring to the diagram in Fig. 1, one can see that the inventive system of modulation does not need the implementation of a whole chain of linear transmission with a converter, but it is enough that the final RF amplifier 5 ensures the linearity needed to perform the amplitude modulation on N levels (i.e. provides a back-off which is enough to such a purpose).

If reference is made to the system of orthogonal coordinates in Figs. 2 and 3 in a bidimensional space, that is characterised by two linearly independent functions  $Y_1$  and



$Y_2$ , it is to be noticed that any arbitrary function can be expressed as a linear combination of said two functions.

Therefore, the baseband signal can be expressed in the form:

$$s(t) = a_1 * Y_1 + a_2 * Y_2$$

while the digital passband modulated signal can be written as:

$$s(t) = A(t) * \cos [\omega_0 t + \phi(t)]$$

wherein  $\omega_0$  is carrier frequency in rad/sec.

Amplitude  $A(t)$  and phase  $\phi(t)$  can be easily expressed in terms of base independent functions  $Y_1, Y_2$ .

It is also possible to draw the modulated signal in a bidimensional space  $Y_1, Y_2$ .

Examples of the inventive system to increase channel capacity in the easy case of a baseband phase modulation and of a RF amplitude modulation are shown in the above Figs. 2 to 5.

Fig. 2 is a simple example of an inventive modulation scheme, with four phase levels and two amplitude levels. This constellation, which is substantially circular, can be provided by using the arrangement in Fig. 1, according to the invention.

A constellation similar to the one represented in Fig. 2 is shown in Fig. 3. It can also be provided by employing the arrangement of Fig. 1 according to the invention and an additional RF phase-shift by  $90^\circ$  is introduced therein. In this case, it is possible to increase the distance between the symbols, so as to improve the system features as for the bit error rate (BER).

Similarly, Figs. 4 and 5 are examples of substantially circular constellations, which are similar to the ones of Figs. 2 and 3 and can be provided according to the invention through a higher number of symbols or signals.

From above, it can be understood that this invention - by separately performing a phase modulation in baseband (PSK) and a RF amplitude modulation (ASK) on the final amplifier, and by using different portions of the same information flow as modulated signal - allows to provide a non-linear transmission chain, up to the final stage. The required output back-off is just the one allowing a RF amplitude modulation; also the requirements on phase noise are closer to the ones of a simple system of phase modulation than to the ones of a linear system of quadrature amplitude modulation.

It is worth noting that - by using M levels of baseband phase-shift and N RF amplitude levels - it is possible to increase the spectral efficiency by a factor  $K = (\log_2 N) / (\log_2 M)$ .

Therefore, for instance, by a simple binary amplitude modulation, performed in RF, and with eight levels of baseband phase-shift, it is possible to double the number of signals from eight (3 bits/symbol) to sixteen (4 bits/symbol). An increase in spectral efficiency by 33% corresponds to that, however with a very small increase in system and hardware complexity.

Since phase and amplitude are orthogonal parameters in a modulated signal, phase modulation and demodulation and amplitude modulation and demodulation can take place independently the one of the other. In case of a scheme of M-ASK/PSK, requirements of the portion of the system RF operating as for phase noise and amplitude linearity are less severe with respect to a traditional scheme of square constellation M-QASK. This increases reliability of performance of the system according to the invention and reduces its production costs.

Flexibility is another important advantage of the inventive modulation system: it is possible to dynamically

choose between the sole phase modulation (PSK) and a combination of phase and amplitude modulation (i.e. between PSK and PSK/ASK) with the same hardware, in order to dynamically balance spectral and power efficiency.

The kind of modulation can be advantageously developed in the future, since it is capable to operate directly from the baseband to radiofrequency, with no need of intermediate frequency conversions; it is virtually possible that a digital circuit and a RF microwave circuit are available, without an intermediate analog frequency.

As for demodulation, the system is still very simple: it is, indeed, enough to provide an envelope detector for recovery of amplitude information and a standard demodulator in baseband.

It is understood that embodiments and/or modifications of the system of amplitude and phase modulation other than the ones described are possible remaining in the scope of this invention. For instance, the voltage controlled oscillator 3 in the block diagram of Fig. 1 could be substituted through another member, apt to generate or to regenerate the phase modulated signal.

## CLAIMS

1. System of phase and amplitude modulation (PSK/ASK) of a single information flow, characterised in that a phase modulation in baseband and a RF frequency modulation are performed separately by using different portions of the same information flow as a modulating signal.

2. System of modulation as claimed in claim 1, wherein a standard, digital phase modulation (PSK) is implemented in baseband in this system of modulation and wherein the number of symbols or signals which form the constellation alphabet is increased by overlapping a digital amplitude modulation (ASK) which is synchronous with the bit flow, directly to a radiofrequency.

3. System of modulation as claimed in claim 1 and 2, wherein M discrete phase-shift levels in baseband and N discrete RF levels of amplitude can be used in the same system.

4. System of modulation as claimed in any claim 1 to 3, which is provided by means of a circuitry comprising in cascade a bit source (1), a digital phase modulator (PSK) (2) in baseband and, in a single block, a voltage controlled oscillator (3), a multiplier (4) and a power amplifier (5).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



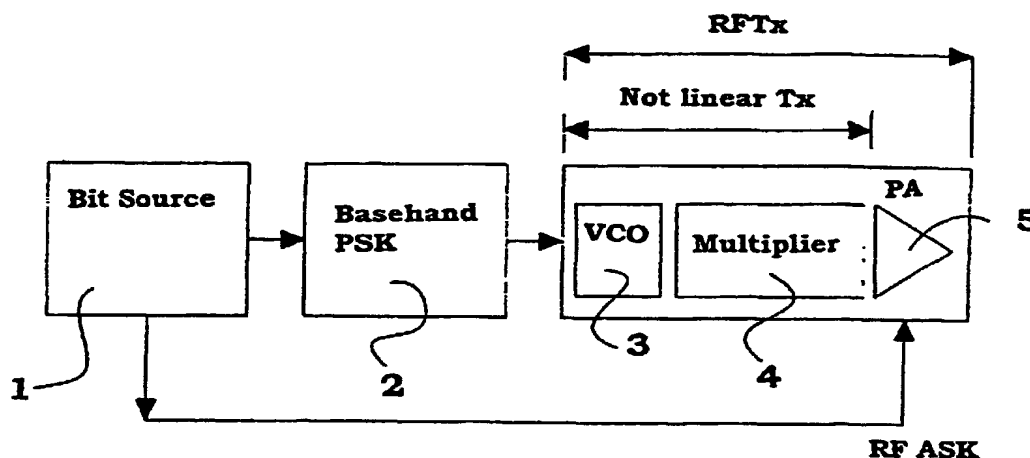
(43) International Publication Date  
21 December 2000 (21.12.2000)

PCT

(10) International Publication Number  
**WO 00/77997 A1**

- (51) International Patent Classification<sup>7</sup>: **H04L 27/36**
- (21) International Application Number: **PCT/IB00/00786**
- (22) International Filing Date: **13 June 2000 (13.06.2000)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:  
99830365.5 **14 June 1999 (14.06.1999)** **EP**
- (71) Applicant (for all designated States except US): **TELEFONAKTIEBOLAGET LM ERICSSON [SE/SE];**  
S-126 25 Stockholm (SE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **MARIOTTI, Marco**  
[IT/IT]; Via Arzani, 32, I-15063 Cassano Spinola (IT). **DE-**  
**CANIS, Carmelo** [IT/IT]; Via Verri, 2B, I-27100 Pavia  
(IT).
- (74) Agents: **VATTI, Paolo et al.; Fumero Studio Consulenza**  
**Brevetti S.n.c., Via S. Agnese, 12, I-20123 Milan (IT).**
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:**  
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **SYSTEM OF DIGITAL PHASE AND AMPLITUDE MODULATION (PSK/ASK)**



(57) Abstract: A phase modulation in baseband and an RF amplitude modulation are separately performed in a system of phase and amplitude modulation (PSK/ASK) of a single information flow, by utilising discrete portions of the same information flow as a modulating signal. Preferably, a digital, standard base modulation (PSK) is implemented in baseband and the number of symbols or signals constituting the constellation alphabet is increased, by overlapping an amplitude modulation synchronous with the bit stream, directly to radiofrequency.



WO 00/77997 A1

- 1/2 -

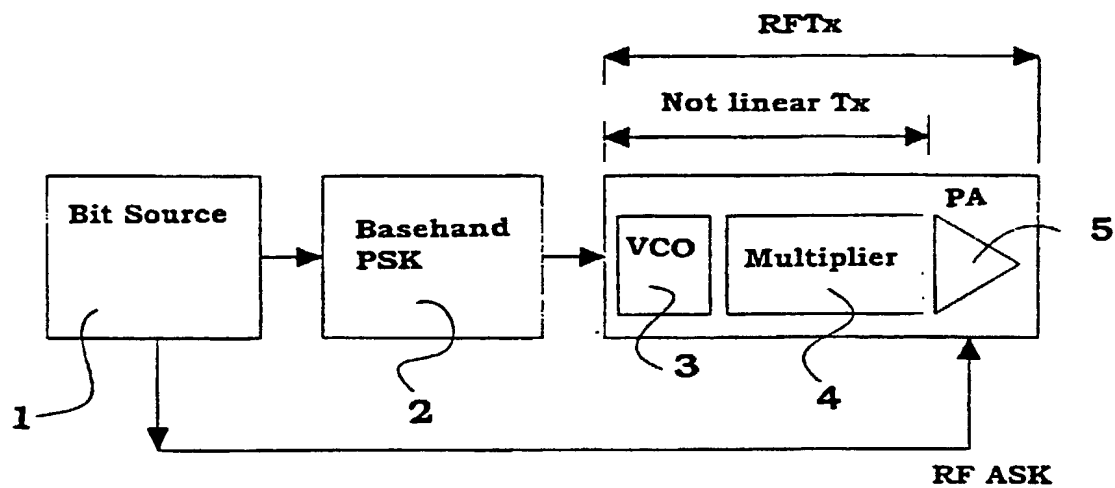


FIG. 1

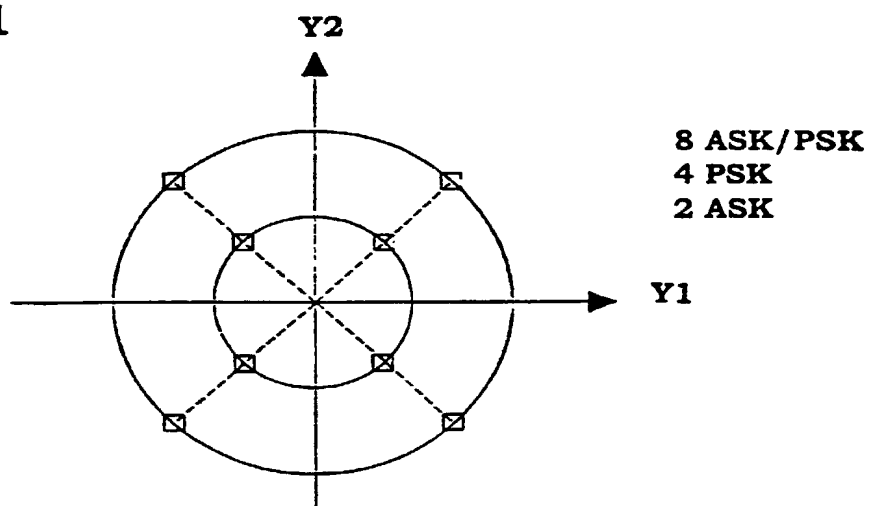


FIG. 2

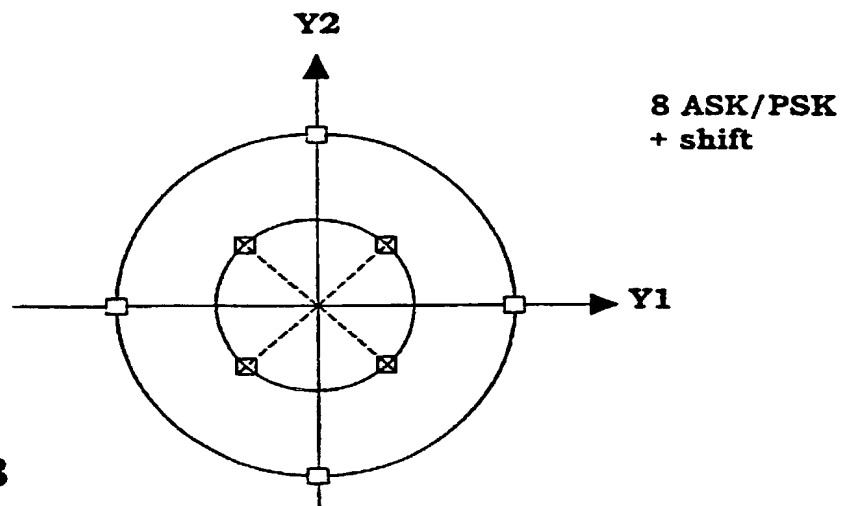


FIG. 3

- 2/2 -

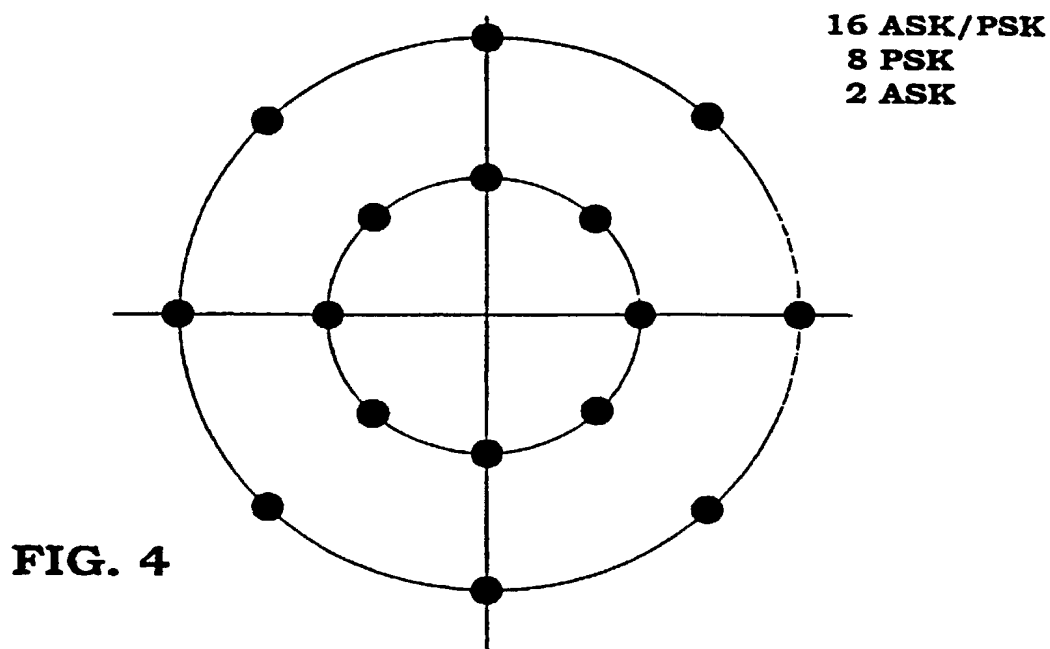


FIG. 4

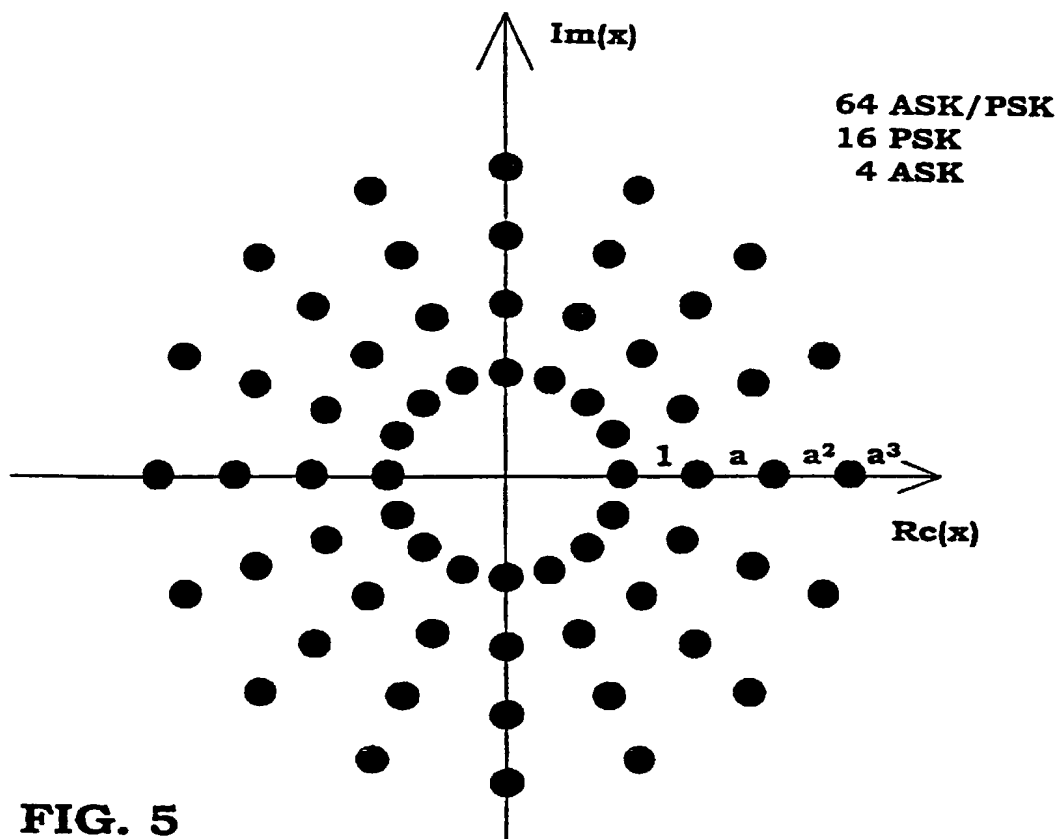


FIG. 5

Nixon & Vanderhye P.C. (12/95)

**RULE 63 (37 C.F.R. 1.63)**  
**DECLARATION AND POWER OF ATTORNEY**  
**FOR PATENT APPLICATION**  
**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

## SYSTEM OF DIGITAL PHASE AND AMPLITUDE MODULATION (PSK/ASK)

the specification of which (check applicable box(s)):

☐ is attached hereto

☒ was filed on December 13, 2001 as U.S. Application Serial No. to be assigned (Atty Dkt. No. 3573-11)

☒ was filed as PCT International application No. PCT/IB00/00786 on 13.06.2000

and (if applicable to U.S. or PCT application) was amended on 26.07.2001

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with 37 C.F.R. 1.56. I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed or, if no priority is claimed, before the filing date of this application:

Priority Foreign Application(s):

Application Number  
00820365

Country  
EUROPE

Day/Month/Year Filed  
14.06.1999

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

Application Number

Date/Month/Year Filed

I hereby claim the benefit under 35 U.S.C. 120/365 of all prior United States and PCT international applications listed above or below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior applications in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. 1.56 which occurred between the filing date of the prior applications and the national or PCT international filing date of this application:

**Prior U.S./PCT Application(s):**

Application Serial No.

Day/Month/Year Filed

Status: patented  
pending, abandoned

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon. And I hereby appoint NIXON & VANDERHYE P.C., 1100 North Glebe Rd., 8<sup>th</sup> Floor, Arlington, VA 22201-4714, telephone number (703) 816-4000 (to whom all communications are to be directed), and the following attorneys thereof (of the same address) individually and collectively my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent: Arthur R. Crawford, 25327; Larry S. Nixon, 25640; Robert A. Vanderhye, 27076; James T. Hosmer, 30184; Robert W. Faris, 31352; Richard G. Besho, 22770; Mark E. Nusbaum, 32348; Michael J. Keenan, 32106; Bryan H. Davidson, 32051; Stanley C. Spooner, 27393; Leonard C. Mitchard, 29009; Duane M. Byers, 33363; Jeffrey H. Nelson, 30481; John R. Lastova, 33149; H. Warren Burnam, Jr. 29366; Thomas E. Byrne, 32205; Mary J. Wilson, 32955; J. Scott Davidson, 33489; Alan M. Kagen, 36178; William J. Griffin, 31260; Robert A. Molan, 29834; B. J. Sadoff, 36663; James D. Berquist, 34776; Updeep S. Gill, 37334; Michael J. Shea, 34725; Donald L. Jackson, 41090; Michelle N. Lester, 32331; Frank P. Presta, 19828; Joseph S. Presta, 35329.\*

1. Inventor's Signature: Marco Martotti Date: 12/27/2001  
Inventor: Marco MARTOTTI  
Italian

Inventor: Marco MARIOTTI Italian  
(first) MI (last) (citizenship)

Residence: (city) 15063 CASSANO SPINOLA (state/country) ITALY

Post Office Address: Via Arzani 32, CASSANO SPINOLA - ITALY

(Zip Code) 15063 CASSANO SPINOLA - Italy

2. Inventor's Signature: Carmelo Deanna Date: 12/27/2001

Inventor: Carmelo (first) MI DECANIS (last) Italian (citizenship)

Residence: (city) 27100 PAVIA (state/country) ITALY

Post Office Address: Via Verri 2B PAVIA - ITALY

(Zip Code) 27100 PAVIA - Italy

3. Inventor's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Inventor: \_\_\_\_\_

| (first) | MI | (last) | (citizenship) |
|---------|----|--------|---------------|
|         |    |        |               |

Residence: (city) (state/country)

Post Office Address: \_\_\_\_\_

(Zip Code) \_\_\_\_\_

**FOR ADDITIONAL INVENTORS, check box ☐ and attach sheet with same information and signature and date for each.**